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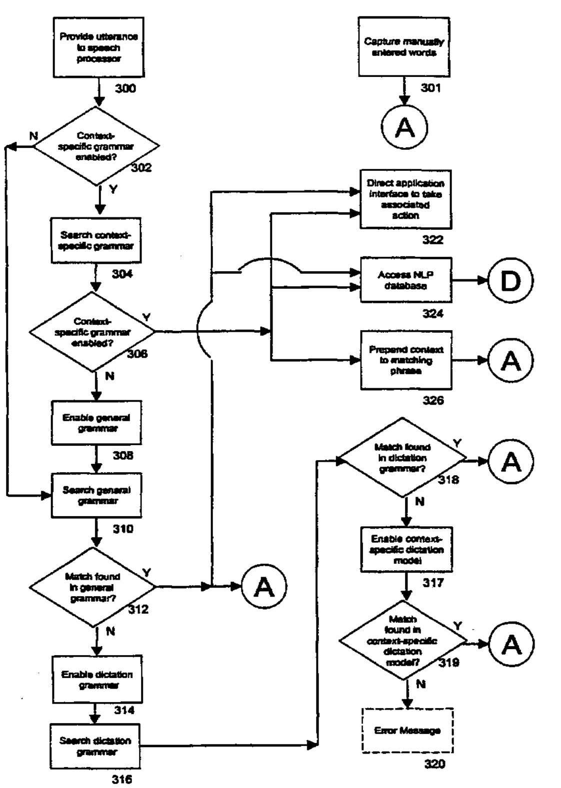

(57) Abstract: A system and method for interacting with objects, via a computer using utterances, speech processing and natural language processing. A Data Definition File relates networked objects and a speech processor. The Data Definition File encompasses a memory structure relating the objects, including grammar files, a context-specific dictation model, and a natural language processor. The speech processor searches a first grammar file for a matching phrase for the utterance, and for searching a second grammar file for the matching phrase if the matching phrase is not found in the first grammar file. The system also includes a natural language processor for searching a database for a matching entry for the matching phrase; and an application interface for performing an action associated with the matching entry if the matching entry is found in the database. The system utilizes context-specific grammars and dictation models, thereby enhancing speech recognition and natural language processing efficiency. Additionally, for each user the system adaptively and interactively "learns" words and phrases, and their associated meanings, storing the adaptive updates into user voice profiles. Because the user voice profiles can be stored locally or remotely, users can access the adaptively learned words and phrases at various locations.

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INTERACTIVE USER INTERFACE USING SPEECH RECOGNITION AND NATURAL LANGUAGE PROCESSING

BACKGROUND OF THE INVENTION

I. Field of the Invention

The present invention relates to speech recognition for an object-based computer user interface. More specifically, the present invention relates to a novel method and system for user interaction with a computer using speech recognition and natural language processing. This application is a continuation-in-part of U.S. Patent Application Serial No. 09/166,198, entitled "Network Interactive User Interface Using Speech Recognition and Natural Language Processing," filed October 5, 1998.

II. Description of the Related Art

As computers have become more prevalent it has become clear that many people have great difficulty understanding and communicating with computers. A user must often learn archaic commands and non-intuitive procedures in order to operate the computer. For example, most personal computers use windows-based operating systems that are largely menu-driven. This requires that the user learn what menu commands or sequence of commands produce the desired results.

Furthermore, traditional interaction with a computer is often slowed by manual input devices such as keyboards or mice. Many computer users are not fast typists. As a result, much time is spent communicating commands and words to the computer through these manual input devices. It is becoming clear that an easier, faster and more intuitive method of communicating with computers and networked objects, such as web-sites, is needed.

One proposed method of computer interaction is speech recognition. Speech recognition involves software and hardware that act together to audibly detect human speech and translate the detected speech into a string of words. As is known in the art, speech recognition works by breaking down sounds the hardware detects into smaller non-divisible sounds called phonemes. Phonemes are distinct units of sound. For example, the word "those" is made up of three phonemes; the first is the "th" sound, the second is the "o" sound, and the third is the "s" sound. The speech recognition software attempts to match the detected phonemes with known words from a stored dictionary. An example of a speech recognition system is given in U.S. Patent No.

4,783,803, entitled "SPEECH RECOGNITION APPARATUS AND METHOD", issued November 8, 1998, assigned to Dragon Systems, Inc., and incorporated herein by reference. Presently, there are many commercially available speech recognition software packages available from such companies as Dragon Systems, Inc. and International Business Machines, Inc.

One limitation of these speech recognition software packages or systems is that they typically only perform command and control or dictation functions. Thus, the user is still required to learn a vocabulary of commands in order to operate the computer.

A proposed enhancement to these speech recognition systems is to process the detected words using a natural language processing system. Natural language processing generally involves determining a conceptual "meaning" (e.g., what meaning the speaker intended to convey) of the detected words by analyzing their grammatical relationship and relative context. For example, U.S. Patent No. 4,887,212, entitled "PARSER FOR NATURAL LANGUAGE TEXT", issued December 12, 1989, assigned to International Business Machines Corporation and incorporated by reference herein teaches a method of parsing an input stream of words by using word isolation, morphological analysis, dictionary look-up and grammar analysis.

Natural language processing used in concert with speech recognition provides a powerful tool for operating a computer using spoken words rather than manual input such as a keyboard or mouse. However, one drawback of a conventional natural language processing system is that it may fail to determine the correct "meaning" of the words detected by the speech recognition system. In such a case, the user is typically required to recompose or restate the phrase, with the hope that the natural language processing system will determine the correct "meaning" on subsequent attempts. Clearly, this may lead to substantial delays as the user is required to restate the entire sentence or command. Another drawback of conventional systems is that the processing time required for the speech recognition can be prohibitively long. This is primarily due to the finite speed of the processing resources as compared with the large amount of information to be processed. For example, in many conventional speech recognition programs, the time required to recognize the utterance is long due to the size of the dictionary file being searched.

An additional drawback of conventional speech recognition and natural language processing systems is that they are not interactive, and thus are unable to cope with new situations. When a computer system encounters unknown or new networked objects, new relationships between the computer and the objects are formed. Conventional speech recognition

and natural language processing systems are unable to cope with the situations that result from the new relationships posed by previously unknown networked objects. As a result, a conversational-style interaction with the computer is not possible. The user is required to communicate complete concepts to the computer. The user is not able to speak in sentence fragments because the meaning of these sentence fragments (which is dependent on the meaning of previous utterances) will be lost.

Another drawback of conventional speech recognition and natural language processing systems is that once a user successfully "trains" a computer system to recognize the user's speech and voice commands, the user cannot easily move to another computer without having to undergo the process of training the new computer. As a result, changing a user's computer workstations or location results in wasted time by users that need to re-train the new computer to the user's speech habits and voice commands.

What is needed is an interactive user interface for a computer that utilizes speech recognition and natural language processing which avoids the drawbacks mentioned above.

SUMMARY OF THE INVENTION

The present invention is a novel and improved system and method for interacting with a computer using utterances, speech processing and natural language processing.

Generically, the system comprises a speech processor for searching a first grammar file for a matching phrase for the utterance, and for searching a second grammar file for the matching phrase if the matching phrase is not found in the first grammar file. The system also includes a natural language processor for searching a database for a matching entry for the matching phrase; and an application interface for performing an action associated with the matching entry if the matching entry is found in the database.

In the preferred embodiment, the natural language processor updates a user voice profile with at least one of the database, the first grammar file and the second grammar file with the matching phrase if the matching entry is not found in the database.

The first grammar file is a context-specific grammar file. A context-specific grammar file is one that contains words and phrases that are highly relevant to a specific subject. The second grammar file is a general grammar file. A general grammar file is one that contains words and phrases which do not need to be interpreted in light of a context. That is to say, the words and phrases in the general grammar file do not belong to any parent context. By searching the context-specific grammar file before searching the general grammar file, the

present invention allows the user to communicate with the computer using a more conversational style, wherein the words spoken, if found in the context specific grammar file, are interpreted in light of the subject matter most recently discussed.

In a further aspect of the present invention, the speech processor searches a dictation grammar for the matching phrase if the matching phrase is not found in the general grammar file. The dictation grammar is a large vocabulary of general words and phrases. By searching the context-specific and general grammars first, it is expected that the speech recognition time will be greatly reduced due to the context-specific and general grammars being physically smaller files than the dictation grammar.

In another aspect of the present invention, the speech processor searches a context-specific dictation model for the matching phrase if the matching phrase is not found within the dictation grammar. A context-specific dictation model is a model that indicates the relationship between words in a vocabulary. The speech processor uses this to determine help decode the meaning of related words in an utterance.

In another aspect of the present invention, the natural language processor replaces at least one word in the matching phrase prior to searching the database. This may be accomplished by a variable replacer in the natural language processor for substituting a wildcard for the at least one word in the matching phrase. By substituting wildcards for certain words (called "word-variables") in the phrase, the number of entries in the database can be significantly reduced. Additionally, a pronoun substituter in the natural language processor may substitute a proper name for pronouns the matching phrase, allowing user-specific facts to be stored in the database.

In another aspect of the present invention, a string formatter text formats the matching phrase prior to searching the database. Also, a word weighter weights individual words in the matching phrase according to a relative significance of the individual words prior to searching the database. These steps allow for faster, more accurate searching of the database.

A search engine in the natural language processor generates a confidence value for the matching entry. The natural language processor compares the confidence value with a threshold value. A boolean tester determines whether a required number of words from the matching phrase are present in the matching entry. This boolean testing serves as a verification of the results returned by the search engine.

In order to clear up ambiguities, the natural language processor prompts the user whether the matching entry is a correct interpretation of the utterance if the required number of words

from the matching phrase are not present in the matching entry. The natural language processor also prompts the user for additional information if the matching entry is not a correct interpretation of the utterance. At least one of the database, the first grammar file and the second grammar file are updated with the additional information. In this way, the present invention adaptively "learns" the meaning of additional utterances, thereby enhancing the efficiency of the user interface.

The speech processor will enable and search a context-specific grammar associated with the matching entry for a subsequent matching phrase for a subsequent utterance. This ensures that the most relevant words and phrases will be searched first, thereby decreasing speech recognition times.

Generically, the invention includes a method for updating a computer for voice interaction with an object, such as a help file or web page. Initially, an object table, which associates with the object with the voice interaction system, is transferred to the computer over a network. The location of the object table can be imbedded within the object, at a specific internet web-site, or at consolidated location that stores object tables for multiple objects. The object table is searched for an entry matching the object. The entry matching the object may result in an action being performed, such as text speech being voiced through a speaker, a context-specific grammar file being used, or a natural language processor database being used. The object table may be part of a dialog definition file. Dialog definition files may also include a context-specific grammar, entries for a natural language processor database, a context-specific dictation model, or any combination thereof.

In another aspect of the present invention, a network interface transfers a dialog definition file from over the network. The dialog definition file contains an object table. A data processor searches the object table for a table entry that matches the object. Once this matching table entry is found, an application interface performs an action specified by the matching entry.

In another aspect of the present invention, the dialog definition file associated with a network is located, and then read. The dialog definition file could be read from a variety of locations, such as a web-site, storage media, or a location that stores dialog definition files for multiple objects. An object table, contained within the dialog definition file, is searched to find a table entry matching the object. The matching entry defines an action associated with the object, and the action is then performed by the system. In addition to an object table, the dialog definition file may contain a context-specific grammar, entries for a natural language processor database, a context-specific dictation model, or any combination thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

The features, objects and advantages of the present invention will become more apparent from the detailed description set forth below when taken in conjunction with the drawings in which like reference characters identify correspondingly throughout and wherein:

FIG. 1 is a functional block diagram of an exemplary computer system for use with the present invention;

FIG. 2 is an expanded functional block diagram of the CPU **102** and storage medium **108** of the computer system of FIG. 1 of the present invention;

FIGS. 3A-3D are a flowchart of the method of providing interactive speech recognition and natural language processing to a computer;

FIG. 4 is a diagram of selected columns of an exemplary natural language processing (NLP) database of the present invention;

FIG. 5 is a diagram of an exemplary Database Definition File (DDF) according to the present invention;

FIG. 6 is a diagram of selected columns of an exemplary object table of the present invention;

FIGS. 7A-7C are a flowchart of the method of the present invention, illustrating the linking of interactive speech recognition and natural language processing to a networked object, such as a web-page;

FIG. 8 is a diagram depicting a computer system connecting to other computers, storage media, and web-sites via the Internet; and

FIG. 9 is a diagram of an exemplary user voice profile according to the present invention;

FIG. 10 is a flowchart of the method of the present invention, illustrating the retrieval and enabling of an individual's user voice profile during login at a computer workstation.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention will now be disclosed with reference to a functional block diagram of an exemplary computer system **100** of FIG. 1. In FIG. 1, computer system **100** includes a central processing unit (CPU) **102**. The CPU **102** may be any general purpose microprocessor or microcontroller as is known in the art, appropriately programmed to perform the method described herein with reference to FIGS. 3A-3D. The software for programming the CPU can be found at storage medium **108** or alternatively from another location across a computer network. For example, CPU **102** may be a conventional microprocessor such as the Pentium II processor manufactured by Intel Corporation or the like.

CPU **102** communicates with a plurality of peripheral equipment, including a display **104**, manual input **106**, storage medium **108**, microphone **110**, speaker **112**, data input port **114** and network interface **116**. Display **104** may be a visual display such as a CRT, LCD screen, touch-sensitive screen, or other monitors as are known in the art for visually displaying images and text to a user. Manual input **106** may be a conventional keyboard, keypad, mouse, trackball, or other input device as is known in the art for the manual input of data. Storage medium **108** may be a conventional read/write memory such as a magnetic disk drive, floppy disk drive, CD-ROM drive, silicon memory or other memory device as is known in the art for storing and retrieving data. Significantly, storage medium **108** may be remotely located from CPU **102**, and be connected to CPU **102** via a network such as a local area network (LAN), or a wide area network (WAN), or the Internet. Microphone **110** may be any suitable microphone as is known in the art for providing audio signals to CPU **102**. Speaker **112** may be any suitable speaker as is known in the art for reproducing audio signals from CPU **102**. It is understood that microphone **110** and speaker **112** may include appropriate digital-to-analog and analog-to-digital conversion circuitry as appropriate. Data input port **114** may be any data port as is known in the art for interfacing with an external accessory using a data protocol such as RS-232, Universal Serial Bus, or the like. Network interface **116** may be any interface as known in the art for communicating or transferring files across a computer network, examples of such networks include TCP/IP, ethernet, or token ring networks. In addition, on some systems, a network interface **116** may consist of a modem connected to the data input port **114**.

Thus, FIG. 1 illustrates the functional elements of a computer system **100**. Each of the elements of computer system **100** may be suitable off-the-shelf components as described above.

The present invention provides a method and system for human interaction with the computer system **100** using speech.

As shown in FIG. 8, the computer system **100** may be connected to the Internet **700**, a collection of computer networks. To connect to the Internet **700**, computer system **100** may use a network interface **116**, a modem connected to the data input port **114**, or any other method known in the art. Web-sites **710**, other computers **720**, and storage media **108** may also be connected to the Internet through such methods known in the art.

Turning now to FIG. 2, FIG. 2 illustrates an expanded functional block diagram of CPU **102** and storage medium **108**. It is understood that the functional elements of FIG. 2 may be embodied entirely in software or hardware or both. In the case of a software embodiment, the software may be found at storage medium **108** or at an alternate location across a computer network. CPU **102** includes speech recognition processor **200**, data processor **201**, natural language processor **202**, and application interface **220**. The data processor **201** interfaces with the display **104**, storage medium **108**, microphone **110**, speaker **112**, data input port **114**, and network interface **116**. The data processor **201** allows the CPU to locate and read data from these sources. Natural language processor **202** further includes variable replacer **204**, string formatter **206**, word weighter **208**, boolean tester **210**, pronoun replacer **211**, and search engine **213**. Storage medium **108** includes a plurality of context-specific grammar files **212**, general grammar file **214**, dictation grammar **216**, context-specific dictation model **217**, and natural language processor (NLP) database **218**. In the preferred embodiment, the grammar files **212**, **214**, and **216** are Bakus-Naur Form (BNF) files, which describe the structure of the language spoken by the user. BNF files are well known in the art for describing the structure of language, and details of BNF files will therefore not be discussed herein. One advantage of BNF files is that hierarchical tree-like structures may be used to describe phrases or word sequences, without the need to explicitly recite all combinations of these word sequences. Thus, the use of BNF files in the preferred embodiment minimizes the physical sizes of the files **212**, **214**, and **216** in the storage medium **108**, increasing the speed at which these files can be enabled and searched as described below. However, in alternate embodiments, other file structures are used.

The context-specific dictation model **217** is an optional file that contains specific models to improve dictation accuracy. These models enable users to specify word orders and word models. The models accomplish this by describing words and their relationship to other words, thus determining word meaning by contextual interpretation in a specific field or topic. Take for example, the phrase "650 megahertz microprocessor computer." A context-specific dictation

model **217** for computers may indicate the likelihood of the word "microprocessor" with "computer," and that a number, such as "650" is likely to be found near the word "megahertz." By interpreting the context of the words, via a context-specific dictation model **217**, a speech recognition processor would analyze the phrase, interpret a single object, i.e. the computer, and realize that "650 megahertz microprocessor" are adjectives or traits describing the type of computer.

Topics for context-specific dictation models **217** vary widely, and may include any topic area of interest to a user—both broad and narrow. Broad topics may include: history, law, medicine, science, technology, or computers. Specialized topics, such as a particular field of literature encountered at a book retailer's web-site are also possible. Such a context-specific dictation model 217 may contain text for author and title information, for example.

Finally, the context-specific dictation model **217** format relies upon the underlying speech recognition processor **200**, and is specific to each type of speech recognition processor **200**.

The operation and interaction of these functional elements of FIG. 2 will be described with reference to the flowchart of FIGS. 3A-3D. In FIG. 3A, the flow begins at block **300** with the providing of an utterance to speech processor **200**. An utterance is a series of sounds having a beginning and an end, and may include one or more spoken words. A microphone **110** that captures spoken words may perform the step of block **300**. Alternately, the utterance may be provided to the speech processor **200** over data input port **114**, or from storage medium **108**. Preferably, the utterance is in a digital format such as the well-known ".wav" audio file format.

The flow proceeds to decision **302** where the speech processor **200** determines whether one of the context-specific grammars **212** has been enabled. If the context-specific grammars **212** are enabled, the context-specific grammars **212** are searched at block **304**. In the preferred embodiment, the context-specific grammars **212** are BNF files that contain words and phrases which are related to a parent context. In general, a context is a subject area. For example, in one embodiment of the present invention applicable to personal computers, examples of contexts may be "news", or "weather", or "stocks". In such a case, the context-specific grammars **212** would each contain commands, control words, descriptors, qualifiers, or parameters that correspond to a different one of these contexts. The use of contexts provides a hierarchal structure for types of information. Contexts and their use will be described further below with reference to the NLP database **218**.

If a context-specific grammar **212** has been enabled, the context-specific grammar **212** is searched for a match to the utterance provided at block **300**. However, if a context-specific grammar **212** has not been enabled, the flow proceeds to block **308** where the general grammar **214** is enabled.

In the preferred embodiment, the general grammar **214** is a BNF file which contains words and phrases which do not, themselves, belong to a parent context, but may have an associated context for which a context-specific grammar file **212** exists. In other words, the words and phrases in the general grammar **214** may be at the root of the hierarchal context structure. For example, in one embodiment applicable to personal computers, the general grammar **214** would contain commands and control phrases.

In block **310**, the general grammar **214** is searched for a matching word or phrase for the utterance provided at block **300**. A decision is made, depending on whether the match is found, at block **312**. If a match is not found, then the dictation grammar **216** is enabled at block **314**. In the preferred embodiment, the dictation grammar **216** is a BNF file that contains a list of words that do not, themselves, have either a parent context or an associated context. For example, in one embodiment applicable to a personal computer, the dictation grammar **216** contains a relatively large list of general words similar to a general dictionary.

In block **316** the dictation grammar is searched for matching words for each word of the utterance provided at block **300**. At decision block **318**, if no matching words are found, any relevant context-specific dictation model **217** is enabled at block **317**.

At decision block **319**, if no matching words are found, a visual error message is optionally displayed at the display **104** or an audible error message is optionally reproduced through speaker **112**, at block **320**. The process ends until another utterance is provided to the speech processor **200** at block **300**.

Thus, as can be seen from the above description, when an utterance is provided to the speech processor **200**, the enabled context-specific grammar **212**, if any, is first searched. If there are no matches in the enabled context-specific grammar **212**, then the general grammar **214** is enabled and searched. If there are no matches in the general grammar **214**, then the dictation grammar **316** is enabled and searched. Finally, if there are not matches in the dictation grammar 316, a context-specific dictation model **217** is enabled **317** and used to interpret the utterance.

In the preferred embodiment, when the speech recognition processor **200** is searching either the context-specific grammar **212** or the general grammar **214**, it is said to be in the

"command and control" mode. In this mode, the speech recognition processor **200** compares the entire utterance as a whole to the entries in the grammar. By contrast, when the speech recognition processor **200** is searching the dictation grammar, it is said to be in the "dictation" mode. In this mode, the speech recognition processor **200** compares the utterance to the entries in the dictation grammar **216** one word at a time. Finally, when the speech recognition processor **200** is matching the utterance with a context-specific dictation model **217**, it is said to be in "model matching" mode. It is expected that searching for a match for an entire utterance in the command and control mode will generally be faster than searching for one word at a time in dictation or model matching modes.

It is further expected that any individual context-specific grammar **212** will be smaller in size (i.e., fewer total words and phrases) than the general grammar **214**, which in turn will be smaller in size than the dictation grammar **216**. Thus, by searching any enabled context-specific grammar **212** first, it is likely that a match, if any, will be found more quickly, due at least in part to the smaller file size. Likewise, by searching the general grammar **214** before the dictation grammar **216**, it is likely that a match, if any, will be found more quickly.

Additionally, as will be explained further below with regard to the ability of the present invention to adaptively add to both the context-specific grammar **212** and the general grammar **214**, they will contain the most common utterances. As such, it is expected that a match is more likely to be found quickly in the context-specific grammar **212** or the general grammar **214** than in the dictation grammar **216**.

Finally, as will be explained further below, the words and phrases in the enabled context-specific grammar **212** are more likely to be uttered by the user because they are words that are highly relevant to the subject matter about which the user was most recently speaking. This also allows the user to speak in a more conversational style, using sentence fragments, with the meaning of his words being interpreted according to the enabled context-specific grammar **212**.

By searching in the above-described sequence, the present invention may search more efficiently than if the searching were to occur one entry at a time in a single, large list of all expected words and phrases.

Referring back to decision **306**, if a match is found in the context-specific grammar **212**, then there are three possible next steps shown in FIG. 3A. For each matching entry in the enabled context-specific grammar **212**, there may be an associated action to be taken by the speech recognition processor **200**. Block **322** shows that one action may be to direct application interface **220** to take some action with respect to a separate software application or entity. For

example, application interface **220** may use the Speech Application Programming Interface (SAPI) standard by Microsoft to communicate with an external application. The external application may be directed, for example, to access a particular Internet web site URL or to speak a particular phrase by converting text to speech. Other actions may be taken as will be discussed further below with reference to the NLP database **218** of FIG. 4.

Block **324** shows that another action may be to access a row in the natural language processing (NLP) database **218** directly, thereby bypassing the natural language processing steps described further below. Block **326** shows that another action may be to prepend a word or phrase for the enabled context to the matching word or phrase found in the context-specific grammar **306**. For example, if the enabled context were "movies" and the matching utterance were "8 o'clock," the word "movies" would be prepended to the phrase "8 o'clock" to form the phrase "movies at 8 o'clock."

Likewise, if a match is found in the general grammar **214**, then the flow may proceed to block **322** where the application interface **220** is directed to take an action as described above, or to block **324** where a row in the NLP database is directly accessed. However, if a match is found in the general grammar **214**, no prepending of a context occurs because, as stated above, the entries in the general grammar **214** do not, themselves, have a parent context.

Alternatively, manually entered words may be captured, at block **301**, and input into the natural language processor.

Finally, with reference to FIG. 3A, words may be entered manually via manual input **106**. In this case, no speech recognition is required, and yet natural language processing of the entered words is still desired. Thus, the flow proceeds to FIG. 3B.

In FIG. 3B, at block **328**, the natural language processor **202** formats the phrase for natural language processing analysis. This formatting is accomplished by string formatter **206** and may include such text processing as removing duplicate spaces between words, making all letters lower case (or upper case), expanding contractions (e.g., changing "it's" to "it is"), and the like. The purpose of this formatting step is to prepare the phrase for parsing.

The flow continues to block **330** where certain "word-variables" are replaced with an associated wildcard function by variable replacer **204** in preparation for accessing the NLP database **218**. As used herein, the term "word-variables" refers to words or phrases that represent amounts, dates, times, currencies, and the like. For example, in one embodiment the phrase "what movies are playing at 8 o'clock" would be transformed at block **330** to "what movies are playing at $time" where "$time" is a wildcard function used to represent any time

value. As another example, in one embodiment the phrase "sell IBM stock at 100 dollars" would be transformed at block **330** to "sell IBM stock at $dollars" where "$dollars" is a wildcard function used to represent any dollar value. This step may be accomplished by a simple loop that searches the phrase for key tokens such as the words "dollar" or "o'clock" and replaces the word-variables with a specified wildcard function. In order to keep track of the location in the phrase where the substitution was made, an array may be used. This allows re-substitution of the original word-variable back into the phrase at the some position after the NLP database **218** has been searched.

The purpose of replacing word-variables with an associated wildcard function at block **330** is to reduce the number of entries that must be present in the NLP database **218**. For example, the NLP database **218** would only contain the phrase "what movies are playing at $time" rather than a separate entry for 8 o'clock, 9 o'clock, 10 o'clock, and so on. The NLP database **218** will be described further below.

At block **332**, pronouns in the phrase are replaced with proper names by pronoun replacer **211**. For example, in one embodiment the pronouns "I," "my," or "mine" would be replaced with the speaker's name. The purpose of this step is to allow user-specific facts to be stored and accessed in the NLP database **218**. For example, the sentence "who are my children" would be transformed into "who are Dean's children" where "Dean" is the speaker's proper name. Again, this step may be performed in a simple loop that searches the phrase for pronouns, and replaces the pronouns found with an appropriate proper name. In order to keep track of the locations in the phrase where a substitution was made, an array may be used.

In block **334**, the individual words in the phrase are weighted according to their relative "importance" or "significance" to the overall meaning of the phrase by word weighter **208**. For example, in one embodiment there are three weighting factors assigned. The lowest weighting factor is assigned to words such as "a," "an," "the," and other articles. The highest weighting factor is given to words that are likely to have a significant relation to the meaning of the phrase. For example, these may include all verbs, nouns, adjectives, and proper names in the NLP database **218**. A medium weighting factor is given to all other words in the phrase. The purpose of this weighting is to allow for more powerful searching of the NLP database **218**.

An example of selected columns of the NLP database **218** of one embodiment is shown in FIG. 4. The NLP database **218** comprises a plurality of columns **400-410**, and a plurality of rows **412A-412N**. In column **400**, the entries represent phrases that are "known" to the NLP database. In column **402**, a number of required words for each entry in column **400** is shown.

In column **404**, an associated context or subcontext for each entry in column **400** is shown. In columns **408** and **410**, one or more associated actions are shown for each entry in column **400**. It should be noted that the NLP database **218** shown in FIG. 4 is merely a simplified example for the purpose of teaching the present invention. Other embodiments may have more or fewer columns with different entries.

Referring back to FIG. 3B, at block **336**, the NLP database **218** is searched for possible matches to the phrase, based on whether the entry in column **400** of the NLP database **218** contains any of the words in the phrase (or their synonyms), and the relative weights of those words. At block **338**, a confidence value is generated for each of the possible matching entries based on the number of occurrences of each of the words in the phrase and their relative weights. Weighted word searching of a database is well known in the art and may be performed by commercially available search engines such as the product "dtsearch" by DT Software, Inc. of Arlington, Virginia. Likewise, searching using synonyms is well known in the art and may be accomplished using such publicly available tools such as "WordNet," developed by the Cognitive Science Laboratory of Princeton University in Princeton, New Jersey. The search engine may be an integral part of the natural language processor **202**.

At decision **340**, the natural language processor **202** determines whether any of the possible matching entries has a confidence value greater than or equal to some predetermined minimum threshold, T. The threshold T represents the lowest acceptable confidence value for which a decision can be made as to whether the phrase matched any of the entries in the NLP database **218**. If there is no possible matching entry with a confidence value greater than or equal to T, then the flow proceeds to block **342** where an optional error message is either visually displayed to the user over display **104** or audibly reproduced over speaker **112**. In one embodiment, the type of error message, if any, displayed to the user may depend on how many "hits" (i.e., how many matching words from the phrase) were found in the highest-confidence NLP database entry. A different type of error message would be generated if there was zero or one hits, than if there were two or more hits.

If, however, there is at least one entry in the NLP database **218** for which a confidence value greater than or equal to T exists, then the flow proceeds to block **344** where the "noise" words are discarded from the phrase. The "noise" words include words that do not contribute significantly to the overall meaning of the phrase relative to the other words in the phrase. These may include articles, pronouns, conjunctions, and words of a similar nature. "Non-noise" words would include words that contribute significantly to the overall meaning of the phrase.

"Non-noise" words would include verbs, nouns, adjectives, proper names, and words of a similar nature.

The flow proceeds to FIG. 3C where the non-noise word requirement is retrieved from column **402** of the NLP database **218** for the highest-confidence matching entry at block **346**. For example, if the highest-confidence matching phrase was the entry in row **412A**, (e.g., "what movies are playing at $time"), then the number of required non-noise words is 3.

At decision **348**, a test is made to determine whether the number of required non-noise words from the phrase is actually present in the highest-confidence entry retrieved from the NLP database **218**. This test is a verification of the accuracy of the relevance-style search performed at block **336**, it being understood that an entry may generate a confidence value higher than the minimum threshold, T, without being an acceptable match for the phrase.

The nature of the test performed at decision **348** is a boolean "AND" test performed by boolean tester **210**. The test determines whether each one of the non-noise words in the phrase (or its synonym) is actually present in the highest-confidence entry. If there are a sufficient number of required words actually present in the highest-confidence entry, then the flow proceeds to block **350**, where the natural language processor **202** directs application interface **220** to take an associated action from column **408** or **410**. It is understood that additional action columns may also be present.

For example, if the highest confidence entry was the entry in row **412A**, and the boolean test of decision **348** determined that there actually were 3 non-noise words from the phrase in the entry in column **400**, then the associated action in column **408** (e.g., access movie web site) would be taken. Other entries in the NLP database have other associated actions. For example, if the highest-confidence entry is that in row **412E** (e.g., "what time is it"), the associated action may be for natural language processor **202** to direct a text-to-speech application (not shown) to speak the present time to the user through the speaker **112**. As another example, if the highest-confidence entry is that in row **412F** (e.g., "show me the news"), the first associated action may be to access a predetermined news web site on the Internet, and a second associated action may be to direct an image display application (not shown) to display images associated with the news. Different or additional actions may also be performed.

Also, if the highest-confidence entry contains the required number of non-noise words from the phrase as determined at decision **348**, the natural language processor **202** instructs the speech recognition processor **200** to enable the context-specific grammar **212** for the associated context of column **404**. Thus, for row **412A**, context-specific grammar **212** for the context

"movies" would be enabled. Thus, when the next utterance is provided to the speech recognition processor **200** in block **300** of FIG. 3A, it would search the enabled context-specific grammar **212** for "movies" before searching the general grammar **214**. As previously stated, enabling the appropriate context-specific grammar **212** greatly increases the likelihood of fast, successful speech recognition, and enhances the user's ability to communicate with the computer in a conversational style.

If, however, back at decision **348**, the required number of non-noise words from the phrase is not actually present in the highest-confidence entry retrieved from the NLP database **218**, then the flow proceeds to block **354** where the user is prompted over display **104** or speaker **112** whether the highest-confidence entry was meant. For example, if the user uttered "How much is IBM stock selling for today," the highest-confidence entry in the NLP database **218** may be the entry in row **412B**. In this case, although the relevance factor may be high, the number of required words (or their synonyms) may not be sufficient. Thus, the user would be prompted at block **354** whether he meant "what is the price of IBM stock on August 28, 1998."

The user may respond either affirmatively or negatively. If it is determined at decision **356** that the user has responded affirmatively, then the action(s) associated with the highest-confidence entry are taken at block **350**, and the associated context-specific grammar **212** enabled at block **352**.

If, however, it is determined at decision **356** that the user has responded negatively, then the flow proceeds to FIG. 3D where the associated context from column **404** of NLP database **218** is retrieved for the highest-confidence entry, and the user is prompted for information using a context-based interactive dialog at block **360**. For example, if the user uttered "what is the price of XICOR stock today," and the highest confidence entry from the NLP database **218** was row **412B** (e.g., "what is the price of IBM stock on $date"), then the user would be prompted at block **354** whether that was what he meant.

If the user responds negatively, then the context "stock" is retrieved from column **404** at block **358**, and the context-based interactive dialog for the stock context is presented to the user over the display **104** and speaker **112**. Such a context-based interactive dialog may entail prompting the user for the name and stock ticker symbol of XICOR stock. The user may respond by speaking the required information. A different context-based interactive dialog may be used for each of the possible contexts. For example, the "weather" context-based interactive dialog may entail prompting the user for the name of the location (e.g., the city) about which weather information is desired. Also, the "news" context-based interactive dialog may entail

prompting the user for types of articles, news source, Internet URL for the news site, or other related information.

Upon completion of the context-based interactive dialog, the NLP database **218**, general grammar **214**, and context-specific grammar **212** are updated to include the new information, at block **362**. In this way, the next time the user asks for that information, a proper match will be found, and the appropriate action taken without prompting the user for more information. Thus, the present invention adaptively "learns" to recognize phrases uttered by the user.

In one embodiment of the present invention, one or more of the NLP database **218**, context specific grammar **212**, general grammar **214**, and dictation grammar **216** also contain time-stamp values (not shown) associated with each entry. Each time a matching entry is used, the time-stamp value associated with that entry is updated. At periodic intervals, or when initiated by the user, the entries that have a time-stamp value before a certain date and time are removed from their respective databases/grammars. In this way, the databases/grammars may be kept to an efficient size by "purging" old or out-of-date entries. This also assists in avoiding false matches.

In an alternate embodiment of the present invention, the updates to the NLP database **218**, general grammar **214**, and context-specific grammar **212** are stored in a user voice profile **800**, shown in FIG. 9. A user voice profile **800** would be comprised of any general grammar additions **214a**, context-specific grammar additions **212a**, and NLP database additions **218a** created by the user training. Since each user of the system would have a different user voice profile **800**, the invention would be flexible enough to allow for special customizations and could adapt to the idiosyncrasies of individual users.

Moreover, in some embodiments of the present invention, the user voice profile **800** would be stored locally and mirrored at known server location. The mirrored copy, referred to as the "travelling" user voice profile, enables users to access their phrases "adaptively" learned by the invention, even when the user is logged into a different location. FIG. 10 illustrates an exemplary method of the present invention that accesses customized user voice profiles **800** at local and remote (travelling) locations. Initially, a valid system user is verified, by any means known in the art, and then the system searches for a locally stored user voice profile. For example, the system queries the user for their login ID and password as shown in block **900**. If the password and login ID match, as determined by decision block **905**, the user is deemed to be a valid user. It is well understood that this login ID and password are but one of many methods known in the art to verify valid users, and that all such validation systems could

be easily substituted. If no local user voice profile is found, block **910**, the system searches for a travelling user voice profile, block **920**. If either search turns up a user voice profile, the user voice profile is loaded, blocks **915** and **925**, respectively. Provided that the retrieval of the user voice profile **800** is successful, blocks **930** and **935**, the user voice profile **800** is enabled by extracting the general grammar additions **214a**, context-specific grammar additions **212a**, and NLP database additions **218a**. These "learned" adaptations are then used by the system, as discussed earlier with the method of FIGS 3A-3D.

In one embodiment of the present invention, speech recognition and natural language processing may be used to interact with objects, such as help files (".hlp" files), World-Wide-Web ("WWW" or "web") pages, or any other objects that have a context-sensitive voice-based interface.

FIG. 5 illustrates an exemplary Dialog Definition File (DDF) **500** which represents information necessary to associate the speech recognition and natural language processing to an internet object, such as a text or graphics file or, in the preferred embodiment, a web-page or help file. Although in its simplest embodiment the Dialog Definition File **500** consists of an object table **510**, the DDF may also contain additional context-specific grammar files **214** and additional entries for the natural language processing (NLP) database **218**, as illustrated in FIG. 5. The preferred embodiment of the DDF **500** includes an object table **510**, a context-specific grammar file **214**, a context-specific dictation model **217**, and a file containing entries to the natural language processing database **218**. These components may be compressed and combined into the DDF file **500** by any method known in the art, such as through Lempel-Ziv compression. The context-specific specific grammar file **214** and the natural language processing database **218** are as described in earlier sections. The object table **510** is a memory structure, such as a memory tree, chain or table, which associates an address of a resource with various actions, grammars, or entries in the NLP database **218**.

An exemplary embodiment of the object table **510** is illustrated in FIG. 6. FIG. 6 illustrates a memory table which may contain entry columns for: an object **520**, a Text-to-Speech (TTS) flag **522**, a text speech **524**, a use grammar flag **526**, an append grammar flag **528**, an "is yes/no?" flag, and "do yes" **532** and "do no" **534** actions. Each row in the table **540A-540*n*** would represent the grammar and speech related to an individual object. The exemplary embodiment of the invention would refer to objects **520** through a Universal Resource Locator (URL). A URL is a standard method of specifying the address of any resource on the Internet

that is part of the World-Wide-Web. As this standard is well known in the art for describing the location of Internet resources and objects, the details of URLs will therefore not be discussed herein. One advantage of URLs is that they can specify information in a large variety of object formats, including hypertext, graphical, database and other files, in addition to a number of object devices and communication protocols. However, as shown in FIG. 6, URLs and other method of specifying objects can be used.

When combined with the text speech **524**, the Text-to-Speech (TTS) flag **522** indicates whether an initial statement should be voiced over speaker **112** when the corresponding object is transferred. For example, when transferring the web page listed in the object column **520** of row **540A** (`http://www.conversit.com`), the TTS flag **522** is marked, indicating the text speech **524**, "Hello, welcome to...," is to be voiced over speaker **112**.

The next three flags relate to the use of grammars associated with this object. The affirmative marking of the "use grammar" **526** or "append grammar" **528** flags indicate the presence of a content-specific grammar file **214** related to the indicated object. The marking of the "use grammar" flag **526** indicates that the new content-specific grammar file **214** replaces the existing content-specific grammar file, and the existing file is disabled. The "append grammar" flag **528** indicates that the new content-specific grammar file should be enabled concurrently with the existing content-specific grammar file.

Lastly, the remaining column entries relate to a "yes/no" grammar structure. If the "Is yes/no?" flag **530** is marked, then a standard "yes/no" grammar is enabled. When a standard "yes/no" grammar is enabled, affirmative commands spoken to the computer result in the computer executing the command indicated in the "Do Yes" entry **532**. Similarly, a negative command spoken to the computer results in the computer executing the command indicated in the "Do No" entry **534**. The entries in the "Do Yes" **532** and "Do No" **534** columns may either be commands or pointers to commands imbedded in the NLP Database **218**. For example, as shown in row **540B**, the "Is Yes/No?" flag is marked. An affirmative answer, such as "yes," given to the computer, would result in executing the corresponding command in the "Do Yes" entry **532**; in this specific case, the entry is the number "210," a reference to the 210th command in the NLP database. An answer of "no" would result in the computer executing the 211th command in the NLP database.

Turning now to FIG. 7A, a method and system of providing speech and voice commands to objects, such as a computer reading a help file or browsing the World-Wide-Web, is illustrated. The method of FIGS. 7A-7C may be used in conjunction with the method of FIGS

3A-3D and FIG. 10. In block **602**, an object location is provided to a help file reader or World-Wide-Web browser. A help file reader/browser is a program used to examine hypertext documents that are written to help users accomplish tasks or solve problems, and is well known in the art. The web browser is a program used to navigate through the Internet, and is well known in the art. The step, at block **602**, of providing an object location to the browser, can be as simple as a user clicking on a program "help" menu item, manually typing in a URL, or having a user select a "link" at a chosen web-site. It also may be the result of a voiced command as described earlier with reference to the action associated with each entry in the NLP database **218**. Given the object location, the computer must decide on whether it can resolve object location specified, at block **604**. This resolution process is a process well known in the art. If the computer is unable to resolve the object location or internet address, an error message is displayed in the browser window, at block **605**, and the system is returned to its initial starting state **600**. If the object location or internet address is resolved, the computer retrieves the object at block **606**. For a networked object, for example, a web browser sends the web-site a request to for the web page, at block **606**. For a help file application, the help reader reads the help file off of storage media **108**, at block **606**.

A decision is made, depending upon whether the object is retrieved, at block **608**. If the object cannot be retrieved, an error message is displayed in the browser window, at block **605**, and the system is returned to its initial starting state **600**. If the object is retrieved, it is displayed in the help-reader or web-site browser, as appropriate, at block **610**.

In decision block **612**, the computer **100** determines whether the DDF file **500** corresponding to the object is already present on the computer **100**. If the DDF file is present, the flow proceeds to FIG. 7C, if not the flow proceeds to FIG. 7B.

Moving to FIG. 7B, if the DDF file **500** is not present, the computer examines whether the DDF file **500** location is encoded within the object. For example, the DDF file location could be encoded within web page HyperText Markup Language (HTML) as a URL. (Note that HTML is well known in the art, and the details of the language will therefore not be discussed herein.) Encoding DDF file location within HTML code may be done either through listing the DDF file location in an initial HTML meta-tag such as:

```
<meta DDF= "http://www.conversit.com/ConverseIt.ddf">
```

or directly through a scripting tag written into the variation of HTML supported by the browser,

```
<!--
```

```
<DDF= "http://www.conversit.com/ConverseIt.ddf">
-->
```

If the DDF file location information is encoded within the web page, the location's internet address is resolved, at block **616**, and the computer requests transfer of the DDF file **500**, at block **626**. An equivalent encoding scheme could be used within help file hypertext.

Alternatively, if the DDF file **500** location is not encoded within the object, there are several alternate places that it may be stored. It may be stored in a pre-defined location at a web-site, such as a certain file location in the root directory, or at a different centralized location, such as another Internet server or the storage medium **108** of FIG. 1. Blocks **618** and **620** test for these possibilities. Block **618** determines whether the DDF file is located at the web-site. At this step, the computer sends query to the web-site inquiring about the presence of the DDF file **500**. If the DDF file **500** is present at the web-site, the computer requests transfer of the DDF file **500**, at block **626**. If the DDF file **500** is not located at the web-site, the computer queries the centralized location about the presence of a DDF file for the web-site, at block **620**. If the DDF file is present at the web-site, the computer requests transfer of the DDF file, at block **626**. If the DDF file **500** cannot be found, the existing components of any present DDF file, such as the object table **510**, context-specific dictation model **217**, NLP database **218** associated with the object, and context-specific grammar **214** for any previously-viewed object, are deactivated in block **622**. Furthermore, the object is treated as a non-voice-activated object, and only standard grammar files are used, at block **624**. Standard grammar files are the grammar files existing on the system excluding any grammars associated with the content-specific grammar file associated with the object.

If the DDF file **500** is requested at block **626**, and its transfer is unsuccessful, any existing components of any present DDF file **500** are deactivated, at block **622**, and the web-site is treated as a non-voice-activated object, and only standard grammar files are used, at block **624**.

If the DDF file **500** is requested at block **626** and its transfer is successful at block **628**, it replaces any prior DDF file, at block **630**. Any components of the DDF file **500**, such as the object table **510**, context-specific-grammar files **214**, context-specific-dictation models **217**, and NLP database **218** are extracted at block **632**. A similar technique may be used for obtaining the software necessary to implement the method illustrated in FIGS. 3A-3D, comprising the functional elements of FIG. 2.

The flow moves to FIG. 7C. The object table **510** is read into memory by the computer in block **634**. If the object is present in the site object table **510**, as determined by block **636**, it will be represented by a row **540A-540*n*** of the table, as shown in FIG. 6. Each row of the object table represents the speech-interactions available to a user for that particular object. If no row corresponding to the object exists, then no-speech interaction exists for the web page, and processing ends.

If the object location is present in the site object table **510**, as determined by block **636**, the computer checks if the TTS flag **522** is marked, to determine whether a text speech **524** is associated with the web-page, at block **638**. If there is a text speech **524**, it is voiced at block **640**, and flow continues. If there is a context-specific grammar file associated with object, as determined by decision block **642**, it is enabled at block **644**, and then the NLP database **218** is enabled at block **646**. If no context-specific grammar file is associated with the object, only the NLP database **218** is enabled at block **646**. Once the NLP database is enabled **646**, the system behaves as FIG. 3A-3C, as described above.

In summary, the present invention provides a method and system for an object interactive user-interface for a computer. By the use of context-specific grammars that are tied to internet-objects through a Dialog Definition File, the present invention decreases speech recognition time and increases the user's ability to communicate with local and networked objects, such as help files or web-pages, in a conversational style. Adaptive updating of the various grammars and the NLP database, the present invention further increases interactive efficiency. The adaptive updates can be incorporated into user voice profiles that can be stored locally and remotely, to allow users access to the user voice profiles at various locations.

The previous description of the preferred embodiments is provided to enable any person skilled in the art to make or use the present invention. The various modifications to these embodiments will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other embodiments without the use of inventive faculty. Thus, the present invention is not intended to be limited to the embodiments shown herein, but is to be accorded the widest scope consistent with the principles and novel features disclosed herein.

I CLAIM:

1. A method for interacting with an object via a computer using utterances, the method comprising the steps of:

searching a context-specific dictation model for a matching phrase for the utterance;

searching a database for a matching entry for the matching phrase; and

performing an action associated with the matching entry if the matching entry is found in the database.

2. The method of claim 1 wherein the object is a web page.

3. The method of claim 1 wherein the object is a help file.

4. A method for interacting with an object via a computer using utterances, the method comprising the steps of:

searching a first grammar file for a matching phrase for the utterance;

searching a second grammar file for the matching phrase if the matching phrase is not found in the first grammar file;

searching a dictation grammar for the matching phrase if the matching phrase is not found in the second grammar file;

searching a context-specific dictation model for the matching phrase if the matching phrase is not found in the dictation grammar file;

searching a database for a matching entry for the matching phrase; and

performing an action associated with the matching entry if the matching entry is found in the database.

5. The method of claim 4 wherein the first grammar file is a context-specific grammar file.

6. The method of claim 5 wherein the second grammar file is a general grammar file.

7. The method of claim 6 further comprising the step of replacing at least one word in the matching phrase prior to the step of searching the database.

8. The method of claim 7 wherein the step of replacing the at least one word comprises substituting a wildcard for the at least one word.

9. The method of claim 8 wherein the step of replacing the at least one word comprises substituting a proper name for the at least one word.

10. The method of claim 9 further comprising the step of text formatting the matching phrase prior to the step of searching the database.

11. The method of claim 9 further comprising the step of weighting individual words in the matching phrase according to a relative significance of the individual words prior to the step of searching the database.

12. The method of claim 4 further comprising the step of updating a user voice profile with at least one of the database, the first grammar file and the second grammar file with the matching phrase if the matching entry is not found in the database.

13. The method of claim 12 further comprising storing the user voice profile locally.

14. The method of claim 12 further comprising storing the user voice profile remote location over a network.

15. The method of claim 12 further comprising storing the user voice profile locally and at a remote location over a network.

16. The method of claim 4 further comprising the step of generating a confidence values for the matching entry.

17. The method of claim 16 further comprising the step of comparing the confidence value with a threshold value.

18. The method of claim 17 further comprising the step of determining whether a required number of words from the matching phrase are present in the matching entry.

19. The method of claim 18 further comprising the step of prompting a user whether the matching entry is a correct interpretation of the utterance if the required number of words from the matching phrase are not present in the matching entry.

20. The method of claim 19 further comprising the step of prompting a user for additional information if the matching entry is not a correct interpretation of the utterance.

21. The method of claim 20 further comprising the step of updating at least one of the database, the first grammar file and the second grammar file with the additional information.

22. The method of claim 21 further comprising storing the user voice profile locally.

23. The method of claim 21 further comprising storing the user voice profile remote location over a network.

24. The method of claim 21 further comprising storing the user voice profile locally and at a remote location over a network.

25. The method of claim 4 wherein the object is a web page.

26. The method of claim 4 wherein the object is a help file.

27. A system for interacting with a computer using utterances, the system comprising:

a speech processor for searching a context-specific grammar file for a matching phrase for the utterance, for searching a general grammar file for the matching phrase if the matching phrase is not found in the context-specific grammar file, for searching a dictation grammar for the matching phrase if the matching phrase is not found in the general grammar file, and for searching a context-specific dictation model if the matching phrase is not found in the dictation grammar;

a natural language processor for searching a database for a matching entry for the matching phrase; and

an application interface for performing an action associated with the matching entry if the matching entry is found in the database.

28. The system of claim 27 wherein the natural language processor updates a user voice profile with at least one of the database, the context-specific grammar file and the second grammar file with the matching phrase if the matching entry is not found in the database.

29. The system of claim 28 wherein the user voice profile is stored locally.

30. The system of claim 28 wherein the user voice profile is stored remotely over a network.

31. The system of claim 28 wherein the user voice profile is stored locally and remotely over a network.

32. The system of claim 28 wherein the speech processor searches a context-specific grammar associated with the matching entry for a subsequent matching phrase for a subsequent utterance.

33. The system of claim 27 further wherein the natural language processor replaces at least one word in the matching phrase prior to searching the database.

34. The system of claim 33 further comprising a variable replacer in the natural language processor for substituting a wildcard for the at least one word in the matching phrase.

35. The system of claim 33 further comprising a pronoun substituter in the natural language processor for substituting a proper name for the at least one word in the matching phrase.

36. The system of claim 27 further comprising a string formatter for text formatting the matching phrase prior to searching the database.

37. The system of claim 27 further comprising a word weighter for weighting individual words in the matching phrase according to a relative significance of the individual words prior to searching the database.

38. The system of claim 27 further comprising a search engine in the natural language processor for generating a confidence value for the matching entry.

39. The system of claim 38 wherein the natural language processor compares the confidence value with a threshold value.

40. The system of claim 39 further comprising a boolean tester for determining whether a required number of words from the matching phrase are present in the matching entry.

41. The system of claim 40 wherein the natural language processor prompts a user whether the matching entry is a correct interpretation of the utterance if the required number of words from the matching phrase are not present in the matching entry.

42. The system of claim 40 wherein the natural language processor prompts a user for additional information if the matching entry is not a correct interpretation of the utterance.

43. The system of claim 42 wherein the natural language processor updates at least one of the database, the first grammar file and the second grammar file with the additional information.

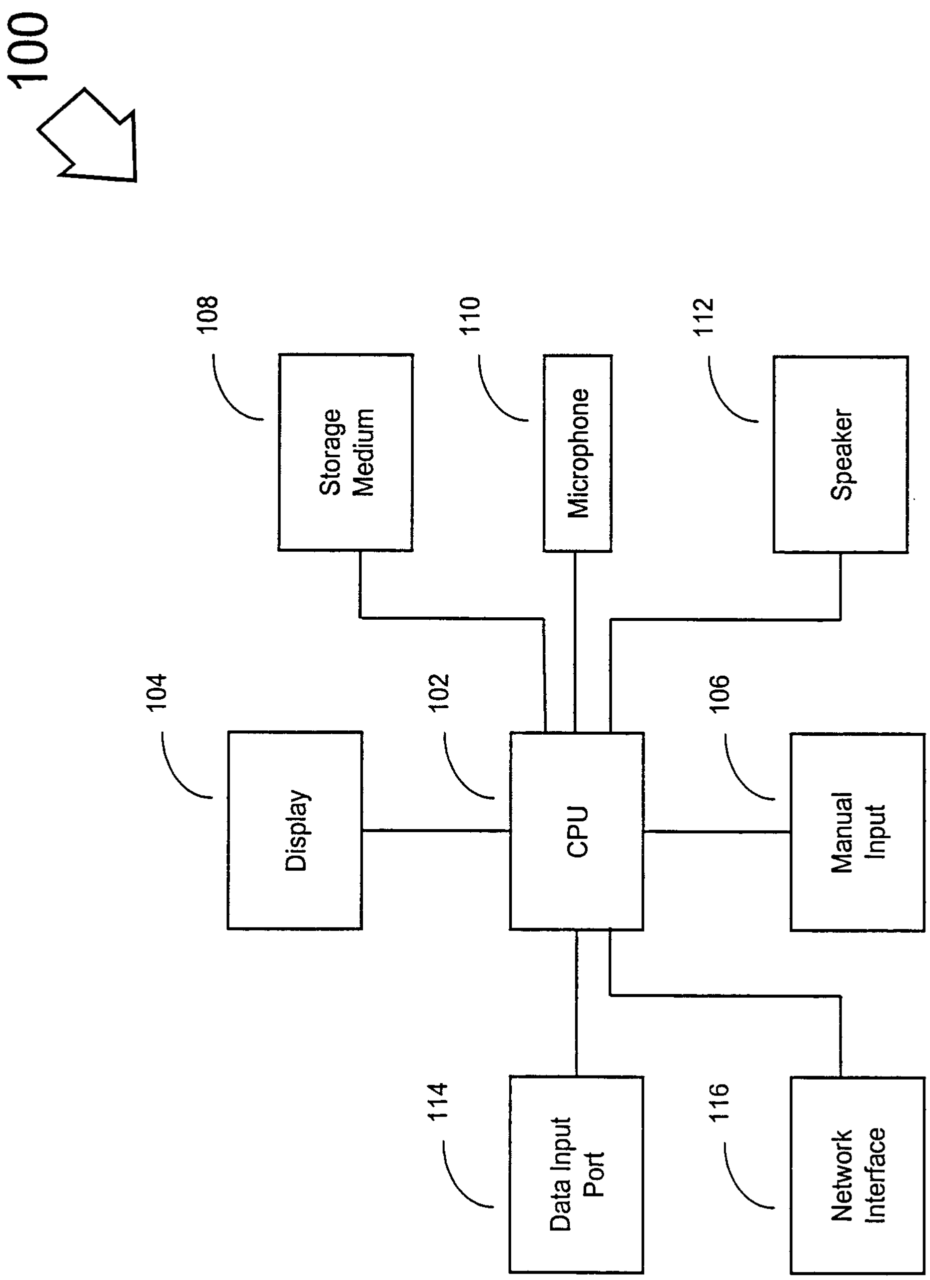
100
108
Storage Medium
110
Microphone
112
Speaker
104
Display
102
CPU
106
Manual Input
114
Data Input Port
116
Network Interface

FIG. 1

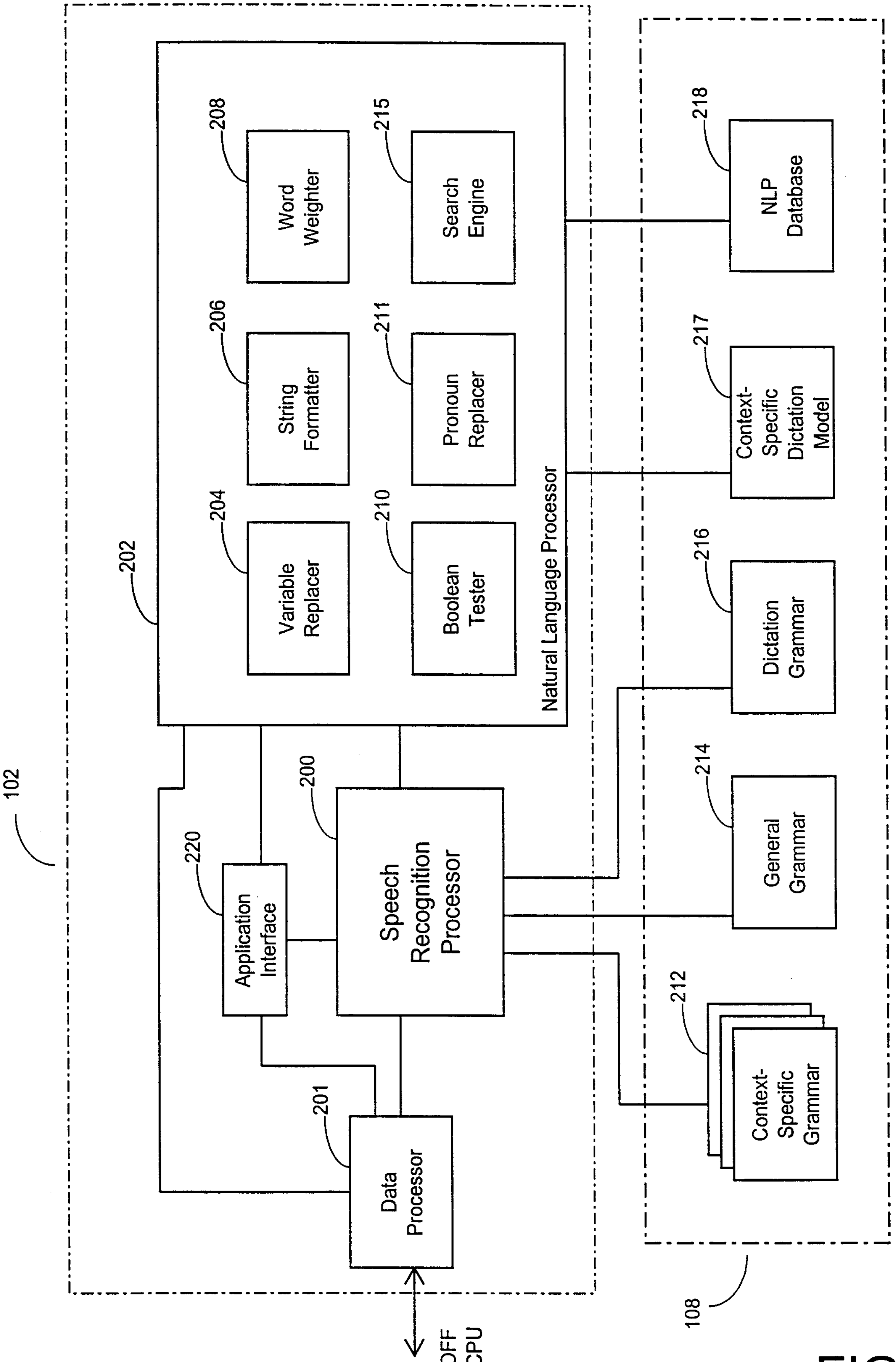
102
202
Natural Language Processor
204
Variable Replacer
206
String Formatter
208
Word Weighter
210
Boolean Tester
211
Pronoun Replacer
215
Search Engine
200
Speech Recognition Processor
220
Application Interface
201
Data Processor
OFF CPU
108
212
Context-Specific Grammar
214
General Grammar
216
Dictation Grammar
217
Context-Specific Dictation Model
218
NLP Database

FIG. 2

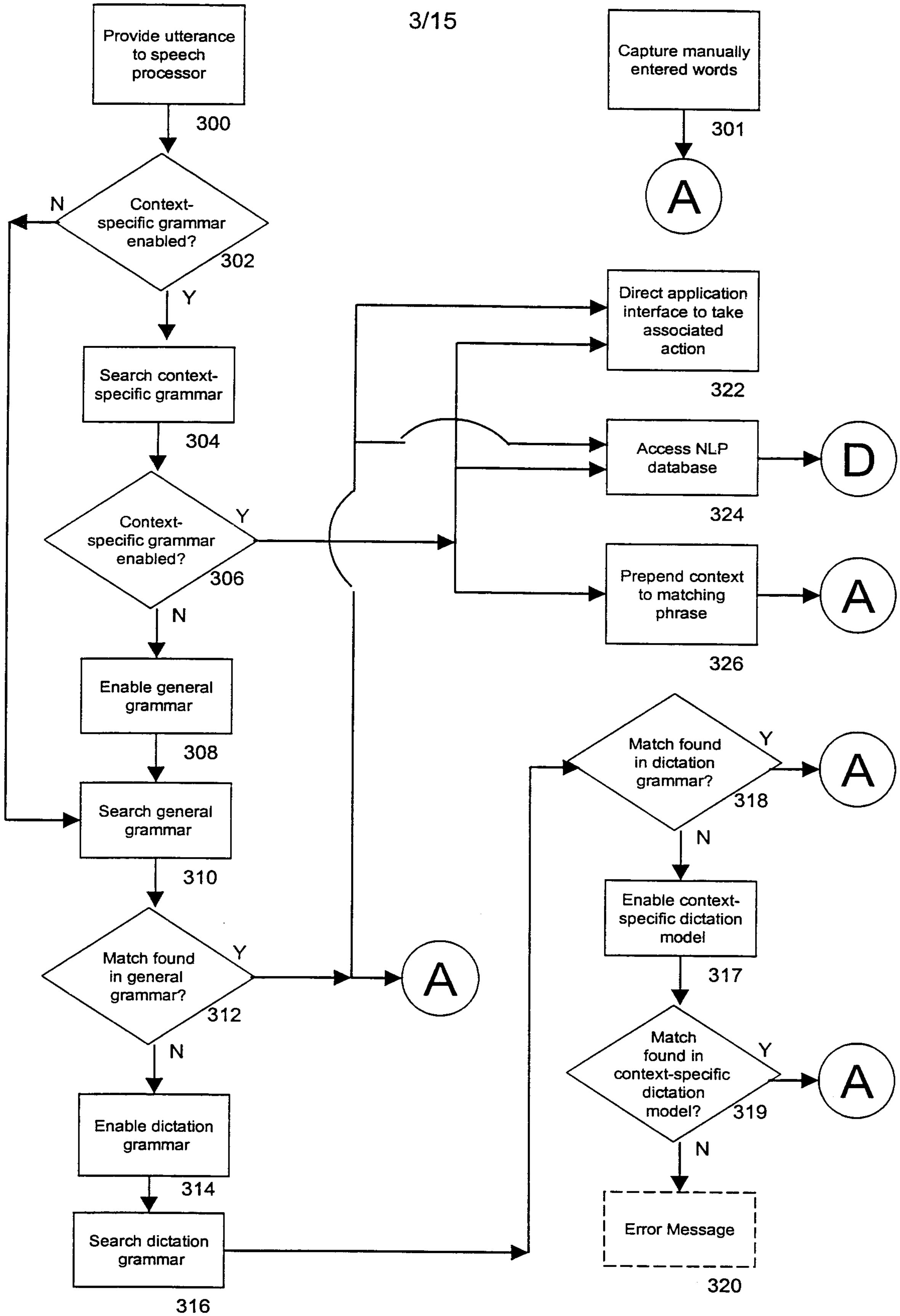
Provide utterance to speech processor
300
Capture manually entered words
301
A
N
Context-specific grammar enabled?
302
Y
Search context-specific grammar
304
Direct application interface to take associated action
322
Access NLP database
324
D
Context-specific grammar enabled?
Y
306
N
Prepend context to matching phrase
326
A
Enable general grammar
308
Search general grammar
310
Match found in dictation grammar?
Y
318
N
A
Enable context-specific dictation model
317
Match found in general grammar?
Y
312
N
A
Match found in context-specific dictation model?
Y
319
N
A
Enable dictation grammar
314
Search dictation grammar
316
Error Message
320

FIG. 3A

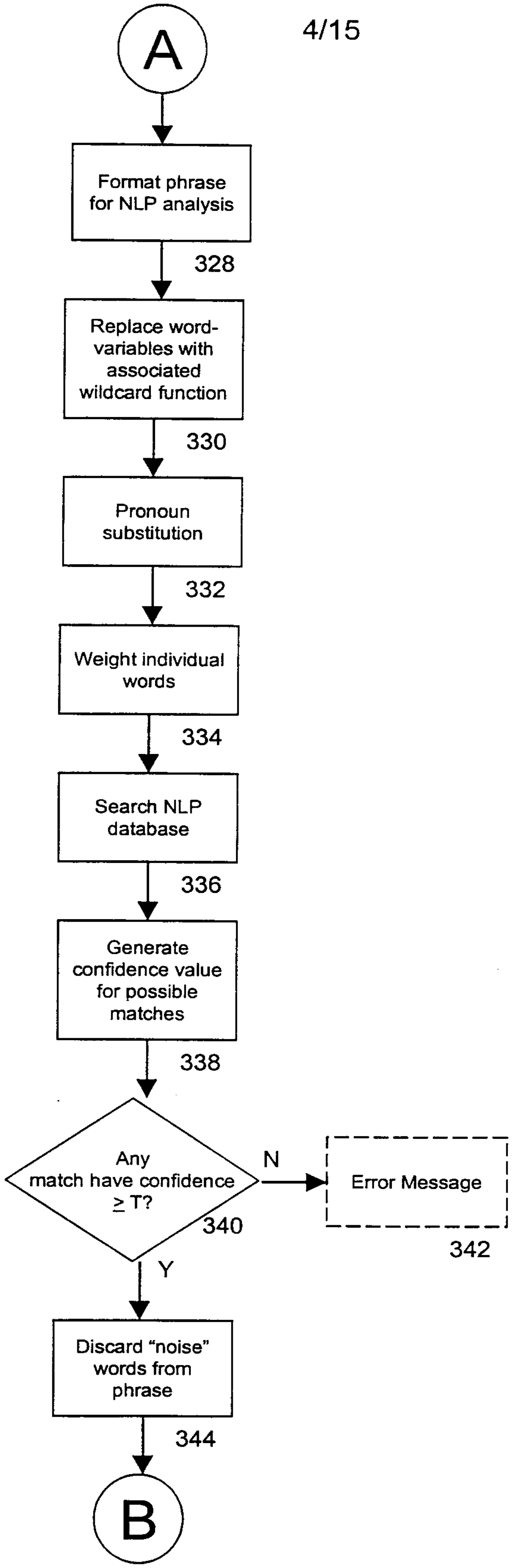
A
Format phrase for NLP analysis
328
Replace word-variables with associated wildcard function
330
Pronoun substitution
332
Weight individual words
334
Search NLP database
336
Generate confidence value for possible matches
338
Any match have confidence ≥ T?
340
N
Error Message
342
Y
Discard "noise" words from phrase
344
B

FIG. 3B

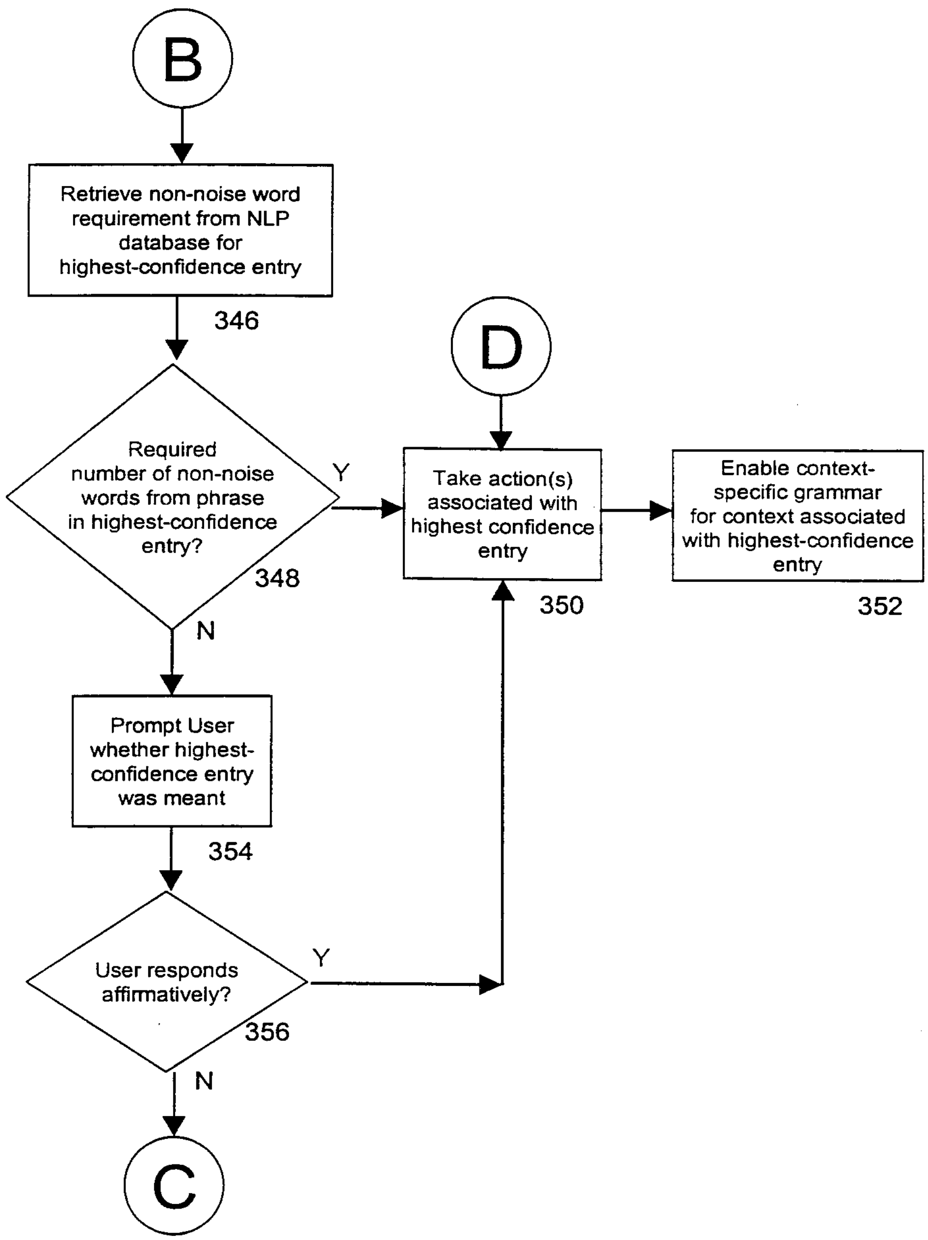
B
Retrieve non-noise word requirement from NLP database for highest-confidence entry
346
D
Required number of non-noise words from phrase in highest-confidence entry?
348
Y
N
Take action(s) associated with highest confidence entry
350
Enable context-specific grammar for context associated with highest-confidence entry
352
Prompt User whether highest-confidence entry was meant
354
User responds affirmatively?
356
Y
N
C

FIG. 3C

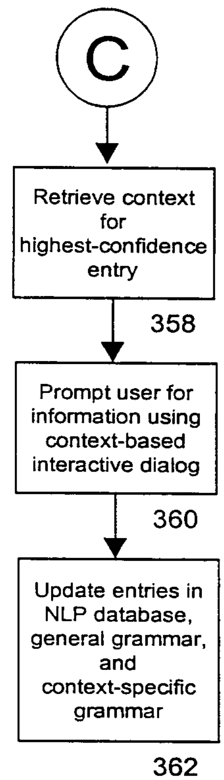
C
Retrieve context for highest-confidence entry
358
Prompt user for information using context-based interactive dialog
360
Update entries in NLP database, general grammar, and context-specific grammar
362

FIG. 3D

218

400 402 404 408 410

Phrase	Required words	Context/Subcontext	Action 1	Action 2
What movies are playing at $time	3	movies	Access movie web site	N/A
What is the price of IBM stock on $date	4	stocks	Access stock price web site	N/A
Sell IBM stock at $dollars	4	stocks	Access stock price web site	N/A
What is the weather at $location	3	weather	Access weather web site	N/A
What time is it	2	time	N/A	Text-to-Speech of Time
Show me the news	2	news	Access news web site	Display Images
How do I format this paragraph	2	Word Processor	Locate Word Processor Help	Format Paragraph Help
...				
How do I insert a table	2	Spreadsheet	Locate Spreadsheet Help	Insert Table Help

412A-n

FIG. 4

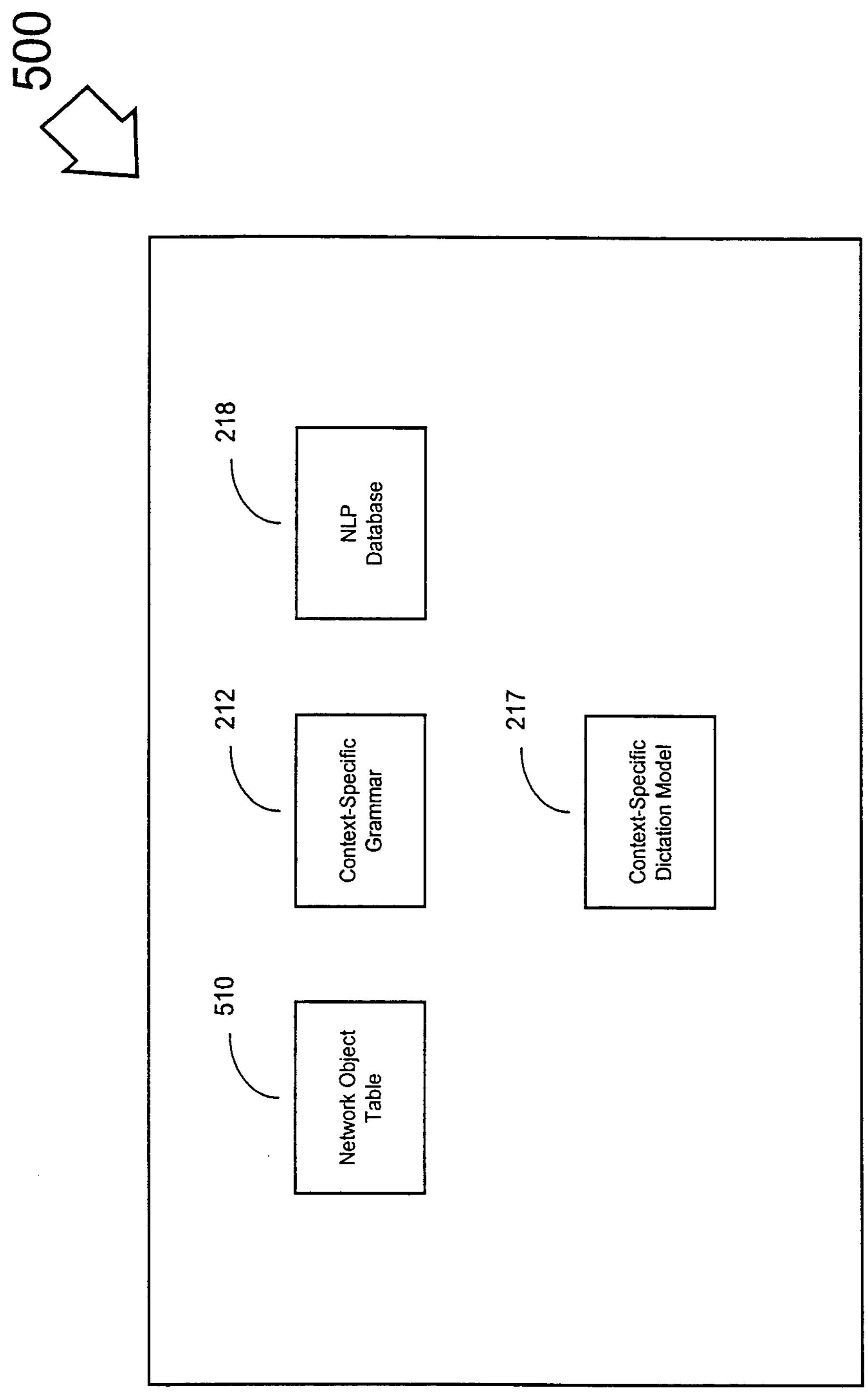
500
218
NLP Database
212
Context-Specific Grammar
217
Context-Specific Dictation Model
510
Network Object Table

FIG. 5

510

520 522 524 526 528 530 532 5

object	TTS Flag	Text Speech	Use Grammar	Append Grammar	Is Yes/No?	Do Yes	Do No
http://www.conversit.com	x	"Hello, welcome to...		x			
http://www.conversit.com/news	x	"Would you like to learn...			x	210	211
http://www.conversit.com/products	x	"All natural language...	x				
http://www.conversit.com/ViaVoice	x	"Via Voice is...					
http://www.conversit.com/search					x	254	213
WPHelp:Format:Paragraph	x	"To format paragraphs...					
⋮							
SpreadsheetHelp:Insert:Table	x	"Inserting Tables is easy..					

540A-*n*

FIG. 6

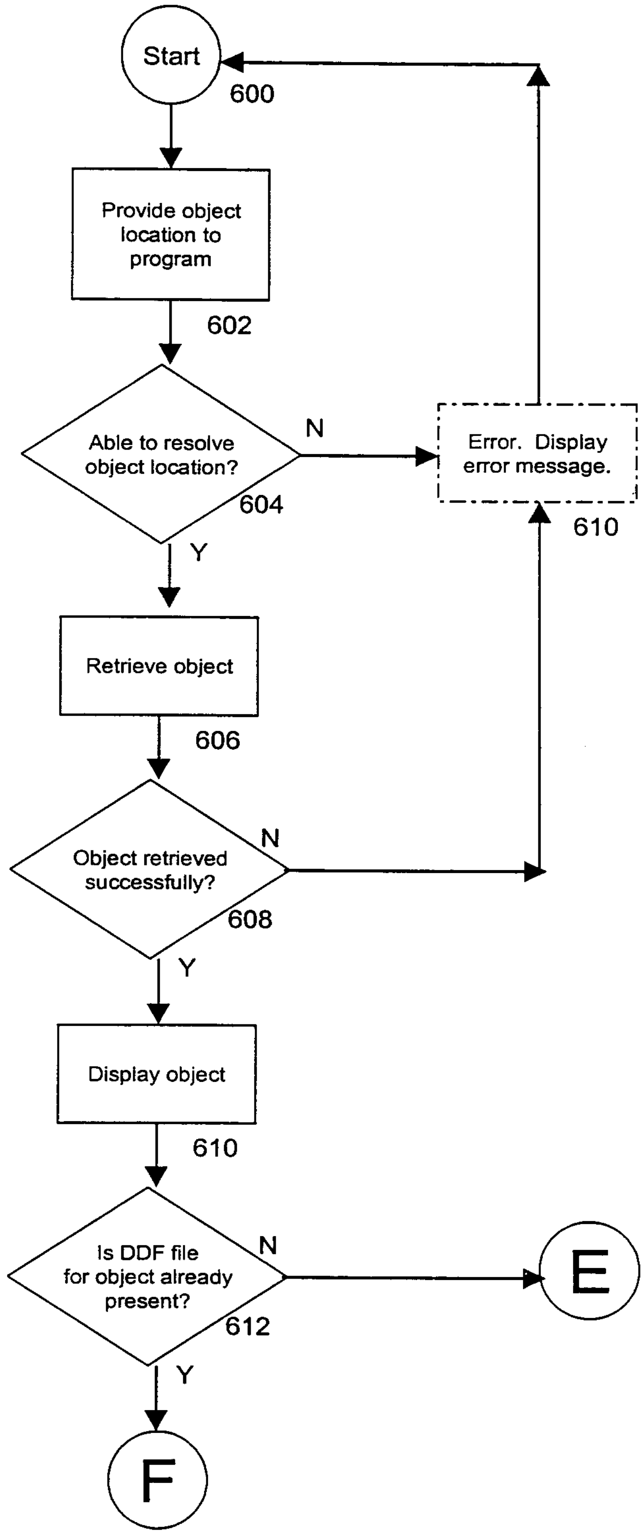
Start
600
Provide object location to program
602
Able to resolve object location?
N
604
Y
Error. Display error message.
610
Retrieve object
606
Object retrieved successfully?
N
608
Y
Display object
610
Is DDF file for object already present?
N
612
Y
E
F

FIG. 7A

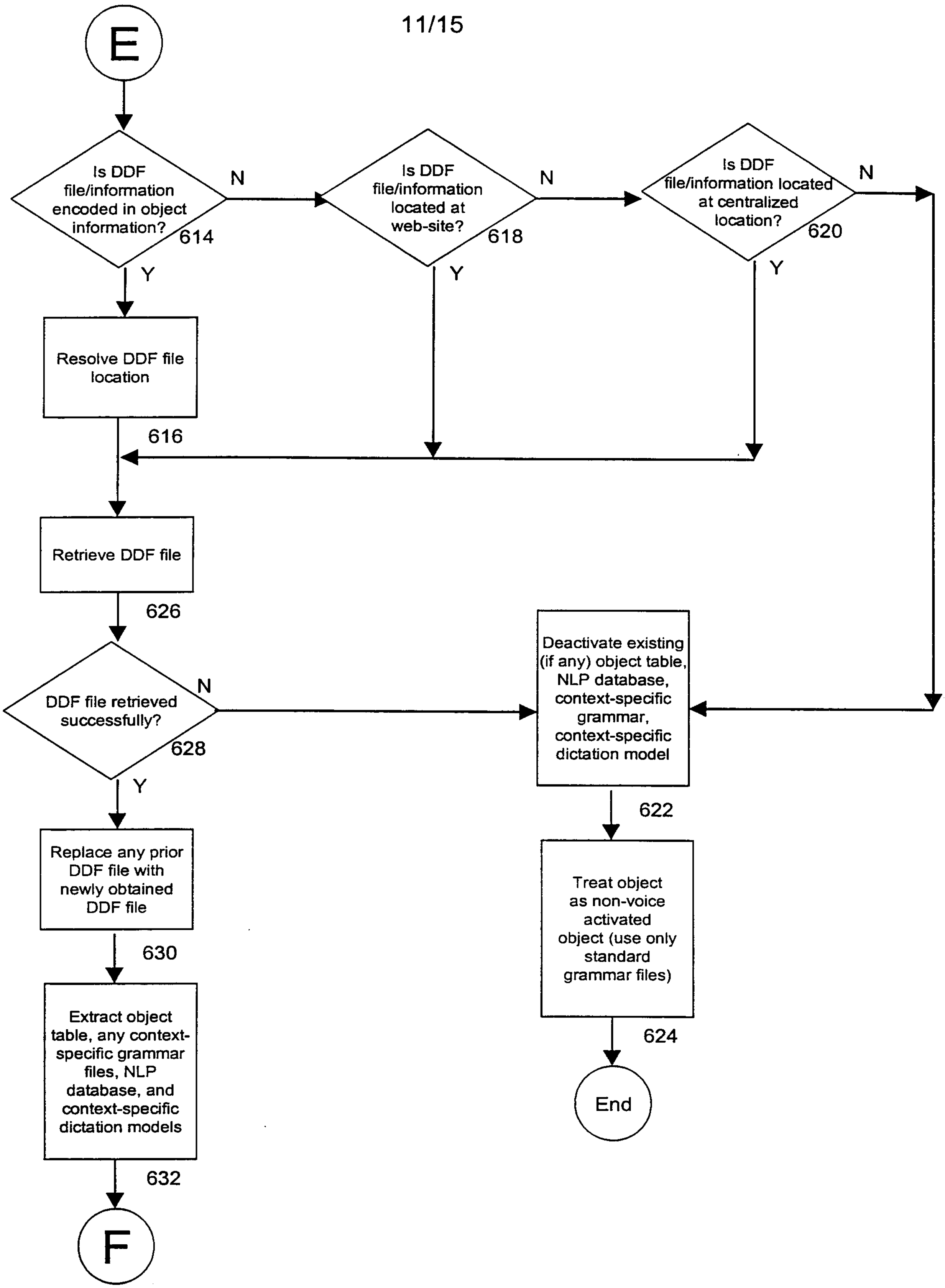
E
Is DDF file/information encoded in object information?
614
N
Y
Resolve DDF file location
616
Is DDF file/information located at web-site?
618
N
Y
Is DDF file/information located at centralized location?
620
N
Y
Retrieve DDF file
626
DDF file retrieved successfully?
628
N
Y
Replace any prior DDF file with newly obtained DDF file
630
Extract object table, any context-specific grammar files, NLP database, and context-specific dictation models
632
F
Deactivate existing (if any) object table, NLP database, context-specific grammar, context-specific dictation model
622
Treat object as non-voice activated object (use only standard grammar files)
624
End

FIG. 7B

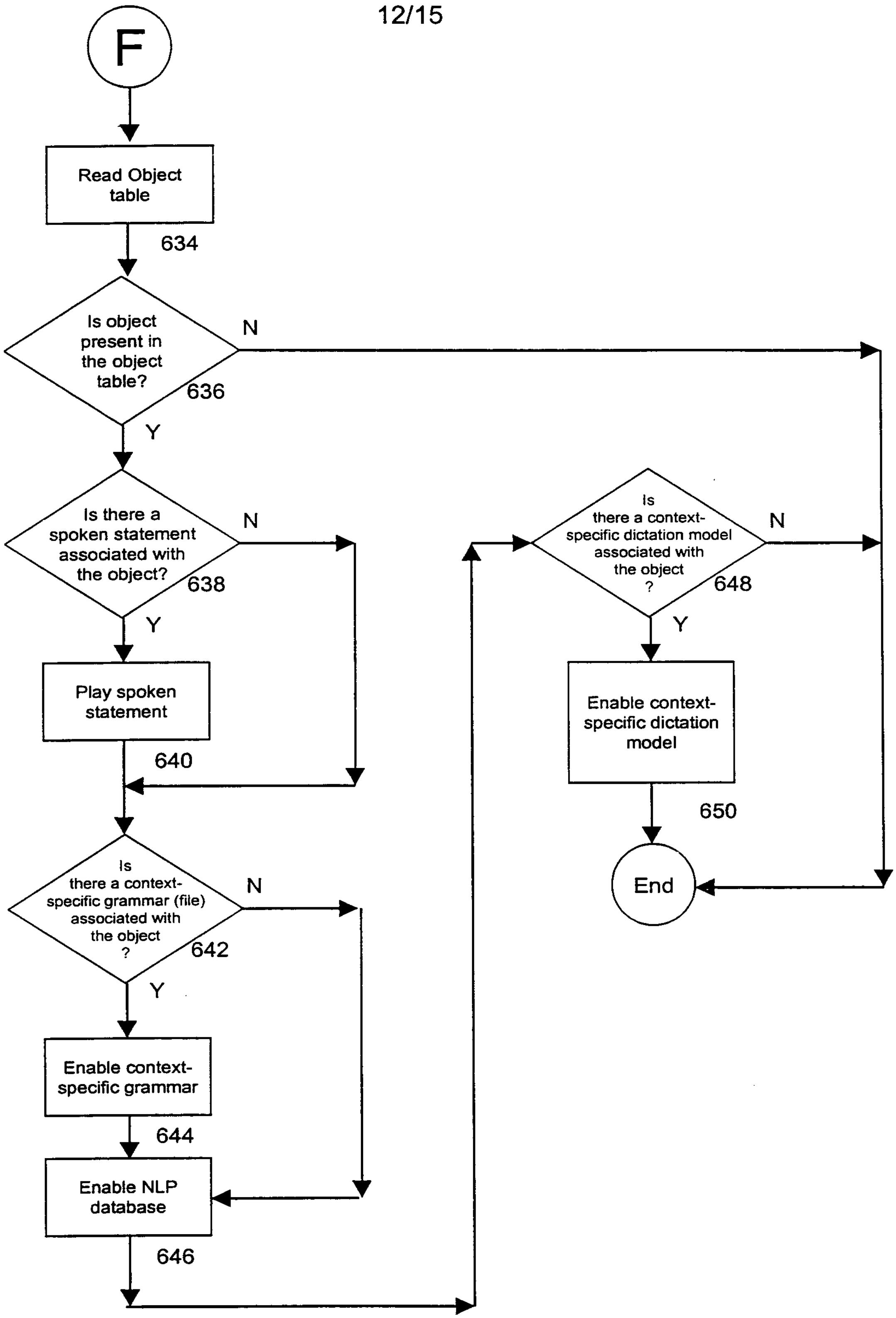
F
Read Object table
634
Is object present in the object table?
636
N
Y
Is there a spoken statement associated with the object?
638
N
Y
Play spoken statement
640
Is there a context-specific grammar (file) associated with the object ?
642
N
Y
Enable context-specific grammar
644
Enable NLP database
646
Is there a context-specific dictation model associated with the object ?
648
N
Y
Enable context-specific dictation model
650
End

FIG. 7C

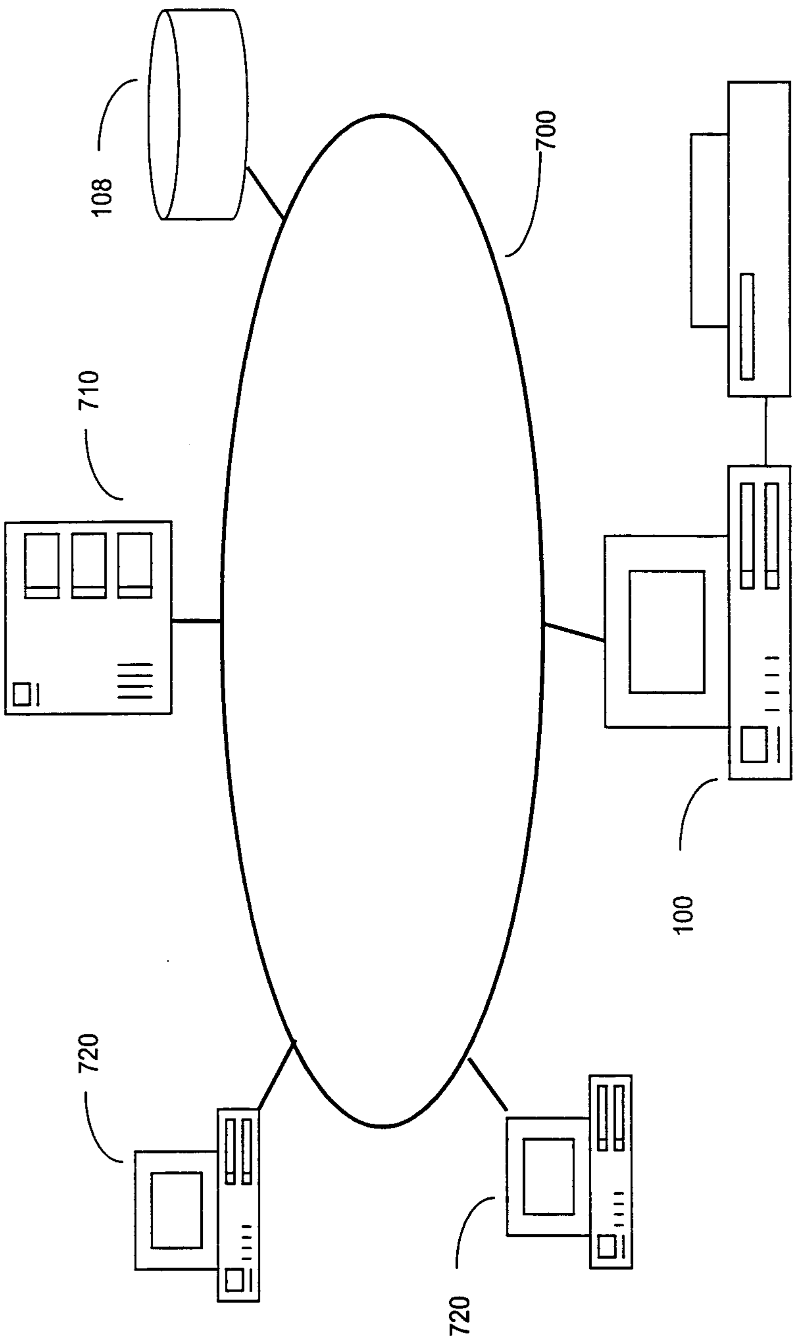

FIG. 8

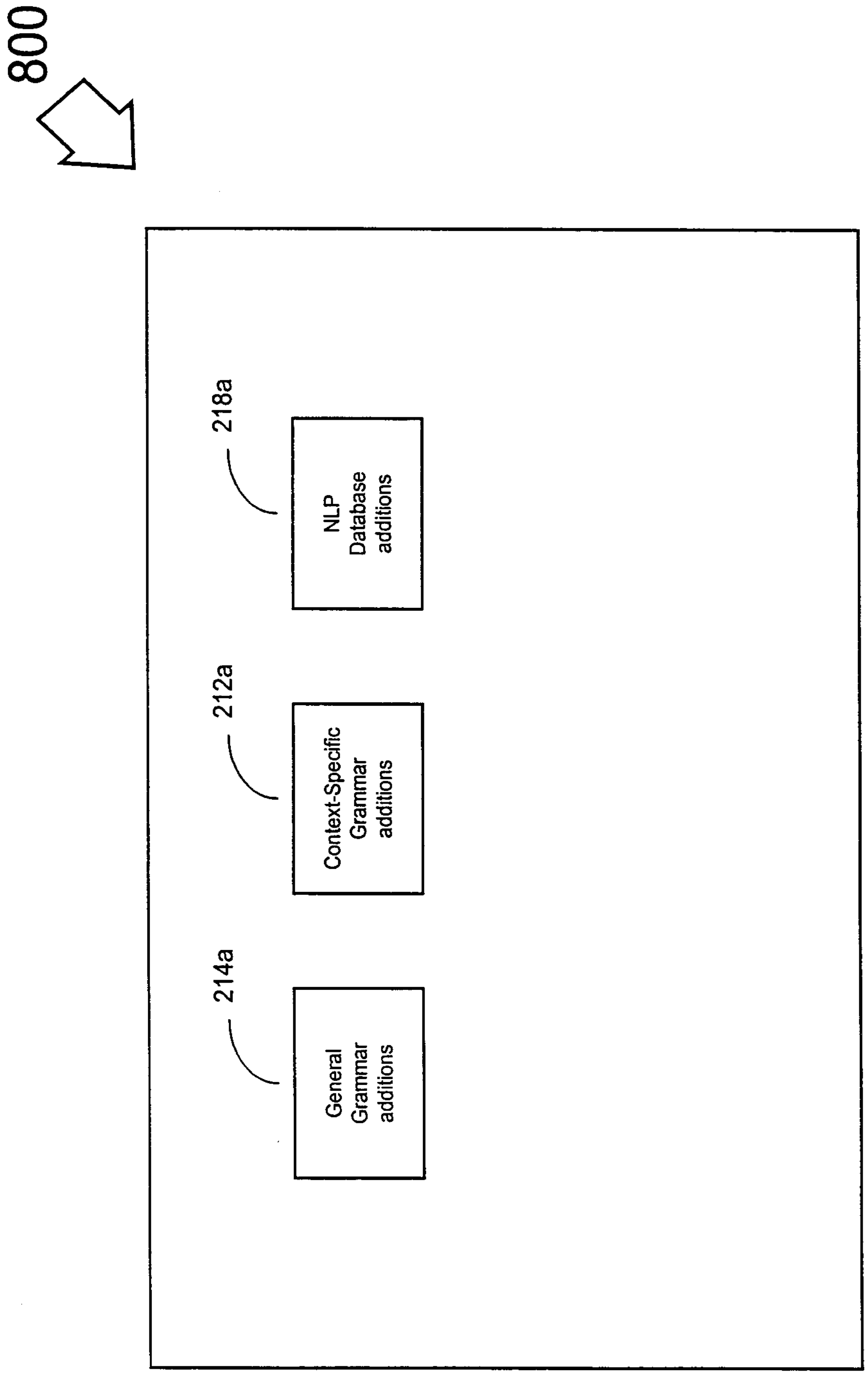
800
218a
NLP
Database
additions
212a
Context-Specific
Grammar
additions
214a
General
Grammar
additions

FIG. 9

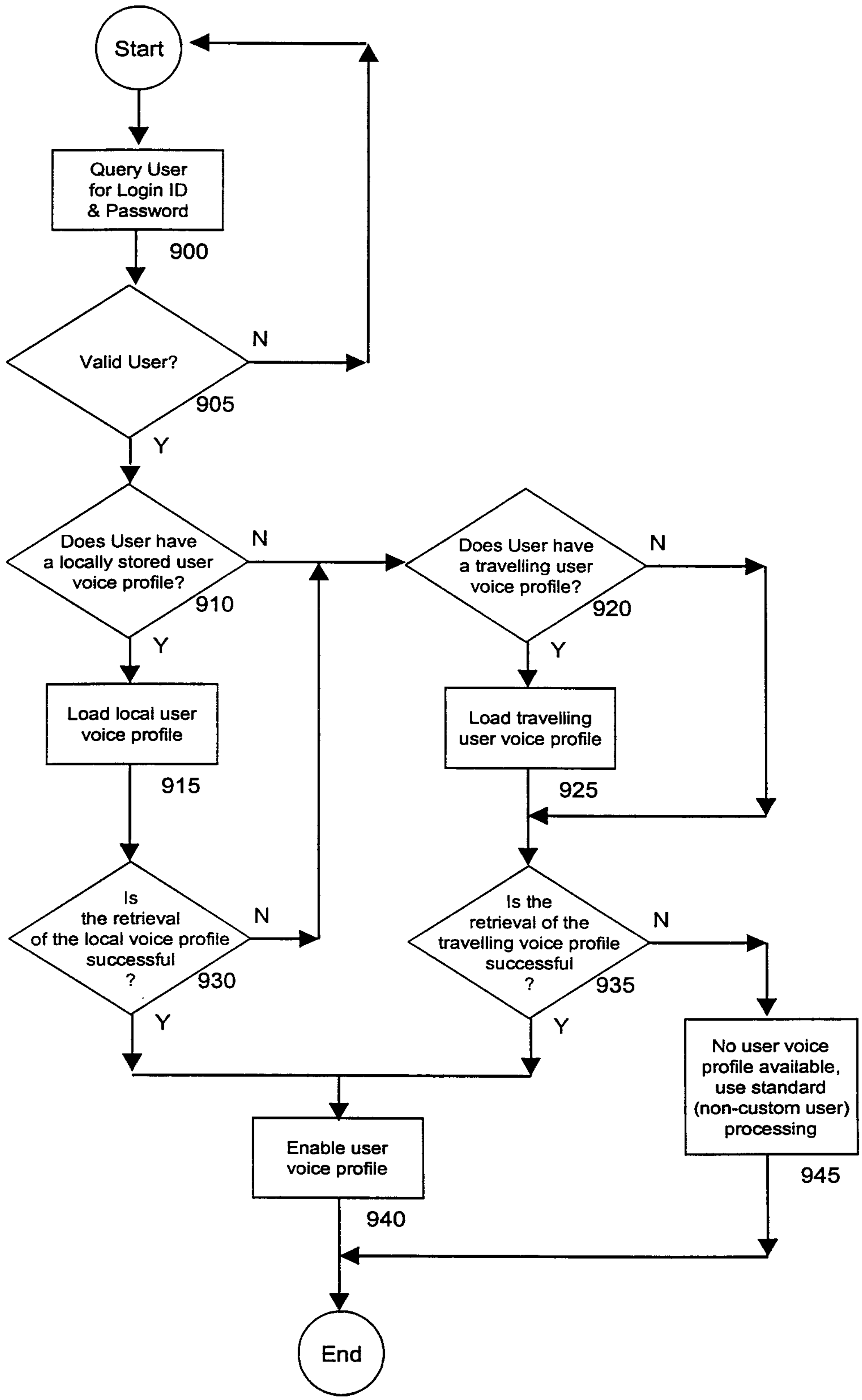
Start
Query User for Login ID & Password
900
Valid User?
N
905
Y
Does User have a locally stored user voice profile?
N
910
Y
Load local user voice profile
915
Is the retrieval of the local voice profile successful ?
N
930
Y
Does User have a travelling user voice profile?
N
920
Y
Load travelling user voice profile
925
Is the retrieval of the travelling voice profile successful ?
N
935
Y
No user voice profile available, use standard (non-custom user) processing
945
Enable user voice profile
940
End

FIG. 10

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 00/27407

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G10L15/22 G10L15/26

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G10L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

INSPEC, COMPENDEX, EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WYARD P J ET AL: "SPOKEN LANGUAGE SYSTEMS - BEYOND PROMPT AND RESPONSE" BT TECHNOLOGY JOURNAL,GB,BT LABORATORIES, vol. 14, no. 1, 1996, pages 187-207, XP000554648 ISSN: 1358-3948	1-6, 25-27
Y	the whole document	7,8, 12-24, 28-34, 36-43

Y	US 5 311 429 A (TOMINAGA MASASUKE) 10 May 1994 (1994-05-10) abstract; figures 1,2	12-15, 21-24, 28-32,43

	-/--	

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 January 2001	25/01/2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Quélavoine, R

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INTERNATIONAL SEARCH REPORT

Interr nal Application No
PCT/US 00/27407

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 0 834 862 A (LUCENT TECHNOLOGIES INC) 8 April 1998 (1998-04-08) abstract; figure 1 ---	16-20, 37-42
Y	"APPROXIMATE WORD-SPOTTING METHOD FOR CONSTRAINED GRAMMARS" IBM TECHNICAL DISCLOSURE BULLETIN,IBM CORP. NEW YORK,US, vol. 37, no. 10, 1 October 1994 (1994-10-01), page 385 XP000475707 ISSN: 0018-8689 the whole document ---	7,8,33, 34,36,37
X	DE 44 40 598 C (SIEMENS AG) 23 May 1996 (1996-05-23) the whole document ---	1-3
P,X	WO 00 14727 A (WEBER DEAN C ;ONE VOICE TECHNOLOGIES INC (US)) 16 March 2000 (2000-03-16) the whole document -----	1-11, 16-21, 25-27, 33-43

1

INTERNATIONAL SEARCH REPORT

ormation on patent family members

Interr nal Application No
PCT/US 00/27407

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
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EP 0834862	A	08-04-1998	US	5797123 A	18-08-1998
			JP	10116094 A	06-05-1998
DE 4440598	C	23-05-1996	US	6029135 A	22-02-2000
WO 0014727	A	16-03-2000	AU	5813099 A	27-03-2000
			AU	6243999 A	27-03-2000
			WO	0014728 A	16-03-2000